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TITLE: Mist generator

Abstract Text (1):
A device for generating a spray of mist or fine droplets includes a spinning rotor within a mist chamber. The rotor has inner walls which taper conically outwardly from the open bottom of the rotor to a hole near the top of the rotor. Liquid is pumped by a finger actuated pump from a cartridge module into a bowl surrounding the bottom end of the rotor. A spray is created as the liquid is formed into droplets as it passes through the hole in the rotor under centrifugal force. A directional light source is used for aiming the spray.

Brief Summary Text (15):
Many women and men would like to use skin care products throughout the day but do not because of the inconvenience of conventional application methods. Most skin care products require the customer to use their fingers or hands to apply and evenly spread the product on the skin. Touching the skin with the fingers, especially for acne-prone people, increases the chances of skin irritation and blemishes. Rubbing products into the skin can also leave greasy or oil residues which may remain on the hands and can be transferred to papers, equipment or other people and forces customers to go to the restroom to wash their hands. This inconvenience results in many people limiting their use of skin care products to the home.

Brief Summary Text (20):
A shortcoming of known aerosol and pump sprays for delivering skin care, fragrances and cosmetic products is the inability to accurately control the amount of spray or mist produced. In addition, the pattern and shape of the spray can be unpredictable, irregular, and vary with the pressure of the propellant or pumping action. Spray velocity and droplet size can also be inconsistent and difficult to control.

Brief Summary Text (21):
In a conventional pump, the spray can be difficult to aim and the spray pattern is poorly focused. Furthermore, pump sprays deliver only a fixed amount of liquid which may exceed the amount desired by a consumer. This lack of control of pump sprays frequently results in products staining clothes, getting into the hair or being sprayed in the eyes or in areas of skin not desired.

Drawing Description Text (13):
FIG. 10 is a right side section view of a composite cartridge and pump model;

Drawing Description Text (17):
FIG. 14A is an exploded right side elevation view of a cartridge and pump module including a cap seal, and a keying arrangement for a nebulizing module;

Drawing Description Text (19):
FIG. 14C is a plan-view of the pump module of FIG. 14A;

Drawing Description Text (20):
FIG. 15A is a rear elevation view of the cartridge and pump modules and cap seal of FIG. 14A;

Drawing Description Text (22):
FIG. 16 is a right side elevation view in part section of a composite pump and cartridge module;

Drawing Description Text (24):

FIG. 18A is an exploded side elevation view of non composite pump and cartridge modules;

Drawing Description Text (25):
FIG. 18B is a side elevation view of a nebulizing module for use with the non composite cartridge and pump modules of FIG. 18A;

Drawing Description Text (27):
FIG. 19A is an exploded rear side elevation view in part section of the non composite pump and cartridge modules of FIG. 18A;

Drawing Description Text (31):
FIG. 21 is a side section view of a composite pump and cartridge module;

Drawing Description Text (41):
FIG. 30 is an exploded view in part section illustrating assembly of the nebulizing, pump and cartridge modules;

Drawing Description Text (74):
FIG. 67 is a plan view fragment of an adjustable pump button;

Drawing Description Text (75):
FIG. 68 is an exploded side elevation view in part section of pump components;

Detailed Description Text (2):
Turning now to the appended drawings, as shown in FIGS. 1-3, the present mist generator 1 is a portable self-contained and compact device for generating a beam or spray of mist. As shown in FIG. 2, the mist generator 1 may be used to apply a spray 7 of liquid to the user's eye. Referring to FIGS. 3 and 4, the present mist generator 1 preferably is of modular construction and includes a nebulizing module 4 attachable to a cartridge module 2. The cartridge module contains a pump module 3 which may be permanently attached to and disposable with the cartridge module. Alternatively, the pump module may be separable from the cartridge module 2 and reusable. When the cartridge module is permanently attached to the pump module, the resulting combination is termed a "composite" module (eg. composite cartridge/pump module 5.)

Detailed Description Text (3):
The modular design provides a high degree of flexibility and potential cost savings. In situations where the mist generator device is used repetitively with a single product (e.g., a fragrance or a sunscreen), only the cartridge module 2 as shown in FIGS. 18 and 19, needs to be replaced when it is empty while the pump module 3 can be reused. Similarly, for many skin care products, a single pump module 3 may be used in conjunction with multiple cartridge modules 2 over many months. By contrast, for over the counter or prescription drug dispensation where the ultimate in cleanliness is important, the single disposable composite pump and cartridge module 5, having the pump module 3 permanently attached to the cartridge module 2, as shown in FIGS. 3, 16 and 17 is used.

Detailed Description Text (14):
As best shown in FIGS. 7 and 8, the pump module 3 has a pump module housing 60. A nebulizing bowl 65 is formed at the front top section of the pump module housing 60. An anti-vortex baffle 66 (FIGS. 7, 22 and 23) extends partway into the nebulizing bowl 65 and prevents the rapidly spinning mist rotor 28 from causing the liquid to form a vortex which would reduce pumping efficiency and mist production. A bowl supply port 73 leads from the nebulizing bowl 65 into the pump module housing. A bracket 57 supports the pump module within the cartridge module (FIG. 30).

Detailed Description Text (15):
Referring to FIGS. 7 and 30, with the pump module 3 assembled to the nebulizing module 4, the upper mist chamber 29 and the nebulizing bowl 65 form a substantially enclosed mist chamber 50. Alternatively, the mist chamber 50 can be formed within an integral component.

Detailed Description Text (16):
As shown in FIGS. 7 and 8, within the pump module housing, an upper check valve 70 and a lower check valve 69 are provided above and below a diaphragm 72. The positions of the check valves in these figures correspond to the positions attained when the pump diaphragm is being depressed and liquid is flowing from the cartridge module into the pump module and from the pump module into the nebulizing bowl. A finger

actuated pump button 67 slidably positioned within the pump module housing 60 overlies the diaphragm 72. An input nozzle 75 extends from the lower check valve downwardly into a bag neck 85 on a flexible plastic bag 84 in the cartridge module containing a liquid medium. The upper check valve 70 output connects with the bowl supply port 73 and prevents any reverse flow from the bowl 65 into the pump or cartridge. Both check valves allow flow only from the plastic bag 84 to the bowl supply port 73. The one-way liquid flow out of the pump and cartridge allows their liquid contents to remain free of potential contamination. Alternatively, the cartridge module housing itself may hold the liquid and no bag is used.

Detailed Description Text (20):
The preferred range of angle A is 0.5 to 1.5 degrees. A small angle is preferred for use with low viscosity spray mediums. A 0.degree. degree angle for angle A, i.e. straight walls, also works but is less efficient as a pump. Larger angles, e.g., 1.5 to 10.degree. degrees or more, for angle A, have a higher pump rate, and may be desired for more viscous mediums. A negative angle A, i.e. a conical chamber wider at the bottom than at the top, could also work if a liquid lifting mechanism is provided, e.g. an Archimedes screw.

Detailed Description Text (21):
The angled rotor bottom, defined by angle C, helps to pick-up small drops remaining in the nebulizing bowl 65 when the medium or the liquid level is low. With angle B at 0 degrees, the rotor also works but is less efficient as a pump and in picking-up drops.

Detailed Description Text (25):
In use, a cartridge module 2 preferably includes a flexible plastic bag 84 containing a liquid medium. The bag is sealed with a removable plug 86, as shown in FIGS. 18 and 20. The flexible bag 84 eliminates the need for air intake, as atmospheric pressure induces collapse and emptying of the bag when the pump is activated. By preventing air from entering the plastic bag, the liquid medium can remain sterile, for drug and preservative free products. Accordingly, sprayed on products which are subject to oxidation are ideally delivered by the mist generator 1, since no externally derived oxygen or other atmospheric contaminants can enter the bag 84 during use and storage.

Detailed Description Text (26):
As shown in FIGS. 16-19, two types of liquid-containing modules which attach to the nebulizing module are provided: (1) a composite module which contains both pump and cartridge components which are permanently fastened together during manufacture, and (2) non-composite pump and cartridge modules which are designed to allow the consumer to reuse the pump module with replacement cartridge modules. When the liquid in the composite module is used up, the entire composite module is intended to be discarded, preferably by recycling. By contrast, when the liquid in the non-composite, detachable pump and cartridge modules is used up, the pump module may be reused by attaching it to a new cartridge module. Alternatively, a partially used cartridge module may be separated from a connected pump module and re-sealed for storage by inserting plug 86 into the neck 85 of bag 84 in the cartridge module. Both composite and non-composite modules are provided with a removable cartridge seal 98 over the nebulizing bowl 65 as shown in FIGS. 14, 15 and 21.

Detailed Description Text (27):
As shown in FIGS. 7 and 8, the lower and upper check valves 69 and 70, respectively, and the diaphragm 72 form a pump 71. The pump 71 accurately delivers a defined amount of liquid from the cartridge and transfers it into the nebulizing bowl 65. Specifically, as the user depresses the pump button 67, the diaphragm 72 is compressed and expels a dose of liquid through the upper check valve 70 into the nebulizing bowl 65, through the bowl supply port 73. The lower check valve 69 and upper check valve 70 produce a uni-directional liquid flow from the cartridge module to the nebulizing bowl 65, without any backflow.

Detailed Description Text (28):
The volume of liquid delivered to the nebulizing bowl 65 by the pump 71 will vary. In ocular versions, each pump actuation will provide a sufficient amount of comfort liquid or drug to saturate the eye without overflowing--about one drop. With skin care products, by contrast, an increased amount of liquid will be delivered to facilitate mist delivery to a larger area of the skin. For products that require a specific volume of liquid to be delivered for each use (e.g., ocular or skin drugs), the volume of liquid delivered by the pump will be advantageously set at one dose of

the substance.

Detailed Description Text (30):
The rotor 28 is designed to function as a pump to draw liquid into the rotor chamber 121 and induce flow upwardly towards the mist hole 128. After the diaphragm pump is actuated, the bottom of the rotor 28 is immersed in the liquid medium contained within the nebulizing bowl 65. As the liquid enters into the bottom of the spinning rotor 28, the liquid accelerates and eventually spins along with the rotor 28. The conical taper of the cone chamber 121 continuously extends to a larger diameter, which, coupled with centrifugal force experienced by the liquid spinning with the rotor, causes the liquid to travel "downhill" on the inclined surface of the rotor and therefore upward towards the top of the rotor chamber 121. As the liquid is forced through the mist hole, mist droplets, of a defined size are formed, and are flung radially outwardly due to the centrifugal force of the spinning rotor. A fraction of the mist droplets exit through the mist port 33 as a focused uniform spray or beam of mist, suitable for a variety of medical, skin care, industrial and household uses. The mist beam travels directly from the rotor to the targeted surface.

Detailed Description Text (36):
For many skin care products, the mist generator 1 will use a rotor 28 selected to produce a mist similar in quality to a fog. Within several seconds, the mist will form a thin liquid layer. In such embodiment, the consumer will experience little or no sensation of mist impact on the skin which will be particularly advantageous for application of products like antiseptics, burn medications or local anesthetics to abraded, burned or otherwise delicate or sensitive skin. Similarly, many other products for skin care may be advantageously applied which include sunscreens or other skin-protective liquids, moisturizers, cosmetics, fragrances, insect repellents, anti-acne medications, antimicrobial substances, products for therapy of skin diseases, lipsome-based products or any other product useful for skin care which can be dispensed as a mist. For industrial or hobby use, lubricants, thinners, paints, solvents, surface-protective products, etc. can be applied, without the use of volatile organic compounds or propellants while avoiding the risk of spills, dripping, splashing, running or impacting on non-intended areas. Of course, for personal, industrial or hobby use, virtually any liquid can be applied by the mist generator. Of course, the outside shape and size of the mist generator may vary with its intended applications. For example, for household and individual uses, the cartridge module may be large and/or handle-shaped.

Detailed Description Text (47):
The dual medium cartridge can be used to substantially solve this problem. In one bag, an ophthalmic drug is contained at an optimum acidic pH to increase stability and solubility. The other bag contains a neutral pH buffer. For this use, the design shown in FIGS. 43-46 is modified so that the selector switch is fixed to allow both bags to be simultaneously emptied by the pump at a mixing ratio which can be determined and fixed during manufacture. By actuating the pump, liquid from both bags is mixed in the pump and nebulizing bowl which results in the buffer changing the pH of the combined solution to a non-irritating neutral pH. Upon activating the motor, the spinning action of the rotor further ensures complete mixing of the solution for optimum comfort and safety.

Detailed Description Text (53):
In another preferred embodiment 170, as shown in FIGS. 51, 52, and 53 an alternative cartridge module 172 is configured to accept a standard medication bottle 174, typically having a volume of up to 15 ml, although larger volumes are possible. As shown in FIG. 52, a nebulizing module 171 attaches to the cartridge module 172 via retainer clip 173. More specifically, as shown in FIGS. 53 and 59, the retainer clip 173 holds a frame 176 of the cartridge module 172 to the nebulizing module 171. A bottle holder 178 is pivotally attached to the frame 176. A tab 175 on the retainer clip 173 engages a step 177 on the bottle holder 178 to hold it closed. Referring to FIGS. 59-62, a plug 182 is attached to a base 180 on the bottle holder 178. A fluid duct 184 connects an opening in the plug 182 to a supply line 186 leading to a pump 188, near the top of the frame 176. A biological air filter 190 which filters microbes, also supported on the frame 176, connects to the air inlet opening 194 in the plug 182 via an airline 192, and the check valve 191 before entering the bottle 174.

Detailed Description Text (55):
Turning to FIGS. 64 and 65, an inlet valve 200 includes a valve body 201 having an

annular valve seat 204. A valve cone 206 also supported by or part of the valve body 201 is spaced apart from the valve seat 204 to form a plenum 210 therebetween. A flexible disk 202, preferably of silicone rubber, is positioned between the valve seat 204 and valve cone 206. The spacing between the point on the valve cone 206 and valve seat 204 is less than the thickness of the rubber disk 202 (preferably approximately 0.030 inches). Accordingly, the point on the valve cone 206 pushes down on the center of the rubber disk 202, to preload the rubber disk 202 against the valve seat 204. Outlet ducts 212 extend to the valve body 201 to the plenum 210, and are joined to an outlet line 211 leading to the pump chamber. When the pump is activated, the reduced pressure on the inlet side causes the rubber disk 202 to bow or dish upwardly, thereby allowing fluid to flow through the inlet valve 200.

Detailed Description Text (56):
Referring to FIGS. 65 and 66, an outlet valve 214 similarly includes a valve body 215 having a seat 216, cone 222 and flexible disk 218. Outlet ducts 226 are provided at the sides of the cone 222. An inlet 224 leads to the positive pressure side of the pump 188. When the pump 188 is actuated, the fluid pressure in the inlet 224 causes the rubber disk 218 to bow upwardly, allowing the inlet 224 to connect into the plenum 220 and to the outlet ducts 226.

Detailed Description Text (57):
Turning now to FIGS. 67 and 68, an adjustable volume pump button assembly 230 has a button 236 including three projections 234 and a slot 238 in its outer surface. The inside surface 242 of the pump button 236 is generally spherical. A button housing 232 around the pump button 236 has detents or slots 241 corresponding to the 3 equally spaced apart pins or projections 234 on the button 236. FIG. 68 shows 1 of the 3 sets of slots which are equally spaced apart on the button housing 232. The button housing 232 is attached to the frame 176 of the cartridge module 172. The inside surface 242 of the pump button 236 presses against a diaphragm 244 in the pump 188. The pump button is attached to the center of the diaphragm via a slot 237 and a tab 239 which holds the pump button in position.

Detailed Description Text (58):
The user of the mist generator can adjust the volume of fluid pumped with each depression of the pump button 236 by turning the pump button 236 using e.g., a thumb nail or coin inserted into the slot 238. The button 236 is rotated over slots 241 to the desired position. Volume indicating marks 246 provided on the mist generator housing around the pump button allow the user to determine the volume setting of the adjustable pump button 230. The interaction of the projections 234 and slots 241 set the allowable travel of the pump button 236, and correspondingly adjust the volume pumped with each movement of the button. Preferably, three selectable volumes are provided.

Detailed Description Text (63):
As fluid is pumped out of the bottle 174 via duct 184 to the pump 188, air enters the bottle to replace the volume of the fluid pumped out. The air passes through the biological filter 190 and through a check valve 191 before entering into the bottle 174 through the air line 192 and air inflow duct 185. The check valve 191 prevents fluid flowing into the filter 190. The filter 190 substantially prevents airborne contaminants from entering into the bottle 174. Operation of the other components of the device 170 is substantially as described above for the device of FIGS. 1-10.

CLAIMS:

1. A mist generator comprising:

a housing;

a mist rotor in the housing having at least one mist hole, rotatably supported substantially within a mist chamber;

a motor linked to the mist rotor;

a pump adjustable to deliver a varying volume of fluid with each actuation of the pump attached to the housing, and separate from the mist rotor for supplying a fluid medium to the mist rotor.

20. A method of spraying a fluid mist comprising the steps of:

pumping fluid with a finger actuated pump to deliver a fluid to a mist chamber;

spinning a mist rotor having a mist hole within the mist chamber, thereby causing the fluid to be drawn up into the mist rotor;

forming fine mist fluid droplets within the mist chamber by passing fluid through the mist hole in the mist rotor under centrifugal force; and

directing the mist of fluid droplets in the direction of an area to be sprayed.